EMGT 835 FIELD PROJECT:
Feasibility Study for a New Business Jet

By

Yasser Abdullah Mousa

Master of Science

The University of Kansas

Fall Semester, 2009

An EMGT Field Project report submitted to the Engineering Management Program and the Faculty of the Graduate School of The University of Kansas in partial fulfillment of the requirements for the degree of Master's of Science.

_____

Linda Miller **Date**
Committee Chair

_____

Tom Bowlin **Date**
Committee Member

_____

Herb Tuttle **Date**
Committee Member

Table of Contents

Table of Figures:

Tables:

Acknowledgement

I would like to thank my committee chairperson Mrs. Linda Miller for her help and support during this project. Linda helped me to put the outline of the project together. She was mentoring my work progress with patience and generosity. Linda taught me with her inputs how to correct the direction of the project toward its objective. Without her help, I could not have finished this project on time.

Secondly, I would like to thank the committee members, my advisor Dr. Tom Bowlin for his continuous help during my study in the Engineering Management program. His effort has always cleared any obstacle delaying my progress. Tom has always encouraged me to do the best and to improve my work quality. In addition, I would like to thank Mr. Herb Tuttle for his valuable inputs to improve the quality of this project.

Finally, I would like to thank my family and friends for their help and support to accomplish the required work. Their support during tough times pushed me to finish the project on time.

Executive summary

This report demonstrates details of a feasibility study of a new business jet as an effort to complete the requirements for a field project (EMGT 835) in Engineering Management. The study is conducted during global economic crisis to identify a promising opportunity in business jet market and then analyze its feasibility as a business opportunity.

The feasibility study starts with a general review of the market of business jet. The review contains customer analysis, which is studying the market definition based on the customer needs and their segments. Then, the industry of business aviation is studied based on the macro-economy, market driven factors, and the market structure. After that, the competition in the market is analyzed by studying every company in the market.

The second half of the study evaluates the market based on the market review to select the best attractive market. Perceptual analysis is used to position a new jet in the market and conjoint analysis is also used to estimate the market share of the new jet. Furthermore, the cost of the new jet is calculated utilizing cost estimation model and the projection of the sales is predicted by bass model. Finally, the financial feasibility of the project is measured through cash flow analysis. In general, the study provides preliminary market assessment, technical assessment, and financial assessment for Very Light Jet market.

1: Introduction

The development of a new Aircraft is a very long process. It takes many years to introduce a new one to the market. Many industries are involved in this process due to the complexity of aerospace products. As a result, all of the other fields related to aerospace industry are affected by any decisions made during this process from the concept design phase throughout prototype test phase and production phase.

A basic decision to pursue a new concept will form the future strategy for the industries working in the project. When Airbus, major aircraft manufacturer, chose to produce giant jumbo jet, many industries responded to that decision by increasing the capability of their product to be able to serve such a giant aircraft. Another example from major aircraft manufacturer is Boeing's decision to build transonic aircraft forced other industries to review their strategies and their decisions to abandon the concept led to reassessment of other industry's strategies.

Therefore, the ability to anticipate the future concept adapted by the industry is crucial for anyone involved in the process. Future opportunity might depend on the correct anticipation of the new concept. It would be helpful for early development of support products or services. Users can utilize this information to initiate plans for the future based on the new product. Regulators would be able to identify the future system needs and put the roles to manage it.

The objective of this project is to conduct a feasibility study of introducing a new business jet in the market using basic information collected in secondary research. Feasibility study is the pre development phase, which helps to make a go/no go decision.

2: Literature Review

2.1: Customer analysis

2.1.1: Market definition:

Business Jet Market is a part of air the transportation industry that consists of different markets competing with each other for customers who want to travel from point to point. Transportation is the basic need of each customer; however, each one also has a different set of other requirements, which guide their decision to utilize any service or product. In this regard, air transportation is not the only way to travel from point to point. The feasibility of the industry products depend on the distance of the trip, the duration of the trip, the load carried in the trip, and finally the affordability of the trip.

Figure 1 shows the classification of the transportation industries to show the location of business jet market among other ways of transportation that may compete with it.

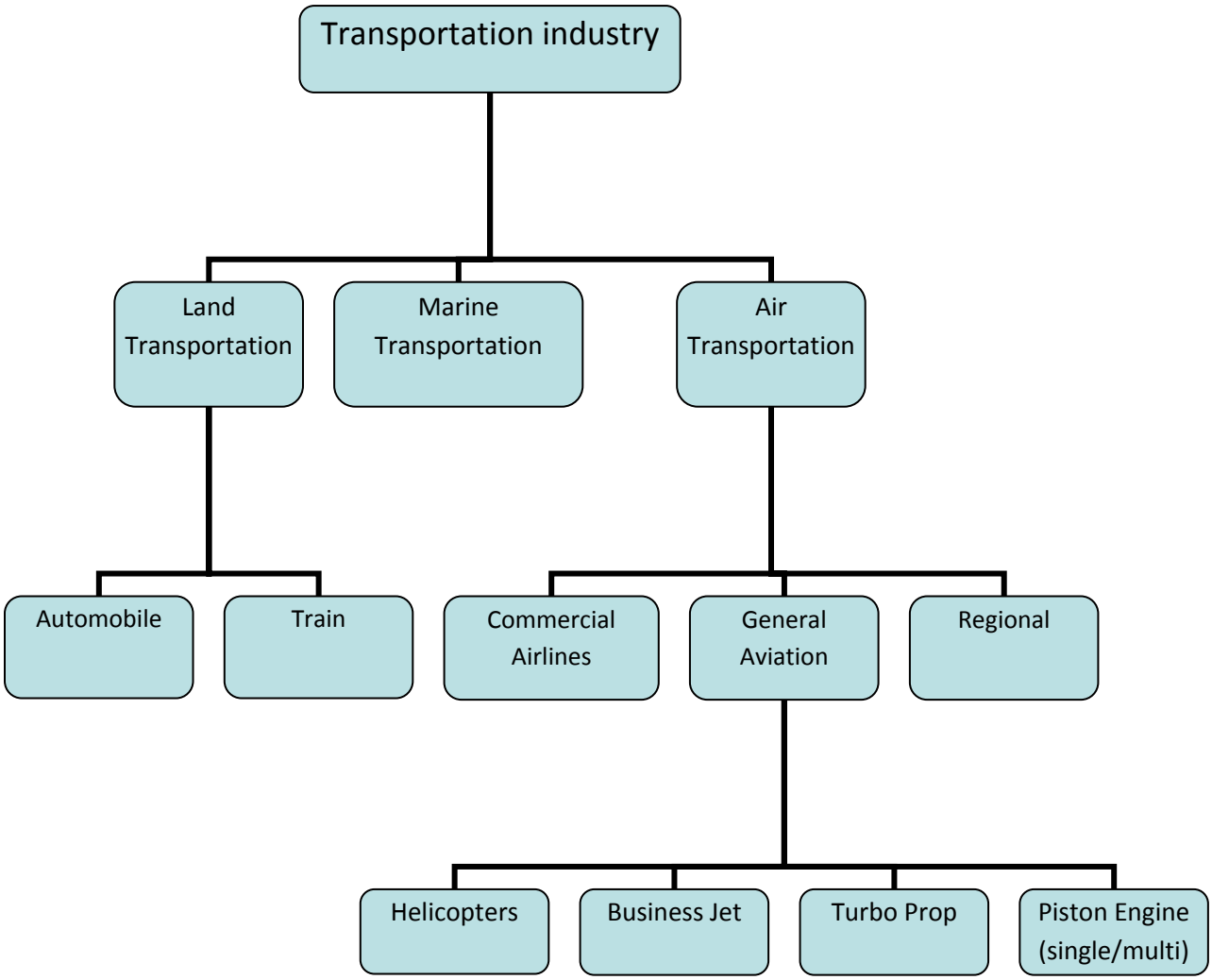

Figure 1: Transportation industry Classification

To define a market, the study adopted a three dimensions system that consists of need, segment, and products dimensions as shown in figure 2. Therefore, a market consists of one or group of needs, segment, and products. For example, a market can be defined for Very Light Jet product, with all needs and all segments as Very Light Jet market. In addition, another market for Very Light Jet product, all needs, Airtaxi can be defined as Very Light Jet for airtaxi market (Alsem, 2007).

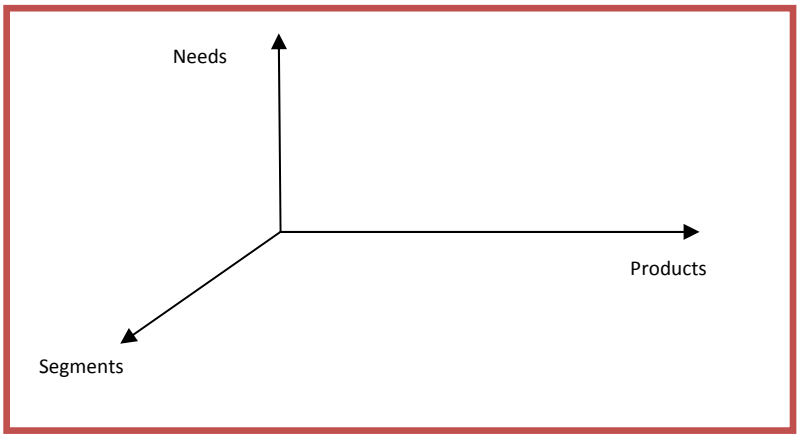

Figure 2: Market definition system

2.1.2: Needs:

The Needs for business jets are divided into three categories based on the nature of the need. They are the need for comfortable transportation, the need for prestige, and the need for profitable operation.

Comfortable transportation

Many travelers find business jet a very comfortable way of traveling in terms of flight time and cabin size. The duration of a trip in business jet is much shorter than other air transportation such as commercial airlines, not because the fight itself, but because of the access time to the aircrafts is shorter. The travelers in business jet do not waste their time in airports waiting on long security lines; they have separate access in other terminals. Business jets are also able to operate from small airports near cities' centers, not like hub airports located far from cities' centers. The comfort of business jets is due to the private large cabin rooms unmatched with any other air transportation. This advantage is obvious with large jets, which look like flying houses or offices. The trip in a business jet is an enjoyable experience

based on the level of comfort during the flight making the people who can afford it excited about it.

Prestige

To own or ride a business jet indicates that the owner or the traveler is in a high class of the society because the cost of a business jet is not affordable to anyone. Business jet customers reflect their image or prestige status as individuals or organizations based on the brand name of the jet and the level of luxury in the jet. Similar to the luxurious automobile industry, the brand name has its effects on the decision of the customer who seek to express certain status. In addition, the demand for higher luxurious features on the jet, such as entertainment equipment, full bedroom, and lavatory, are determined by level life standard. All these luxurious features in addition to the brand name increase the value of the business jet more than the standard.

Profitable operation

Business jets are a very useful way of transportation, but they are also very expensive. Not only acquisition price makes business jets expensive to own, but also operation expenses add high cost to owners. These expenses include fuel price, pilot salary, maintenance cost, and parking fees. Therefore, affordability is an important factor in purchase decision; however, with the existence of many other transportation systems, the cost to value created is becoming more important than affordability in purchase decisions. This is clear in services, which use business jets to provide their services such as Airtaxi firms. These firms are more concerned about the profitability of the operations.

2.1.3: Customers Segments:

The segmentation of the customers is done using industry sector criteria. The chosen criteria are to identify homogeneous, sufficient size, measurable, and accessible segment (Alsem, 2007).

Individual owners segment:

According to Thomas Kostigen from Market Watch, the average of annual income of business jet owners is 9.2 million and 89.3 million net wealth. He said that these individual owners are 57-years-old in average with a majority of men (Kostigen, 2006). World Wealth Report in 2007 estimates the number of individuals with net weath more than $30 million around the world by 95,000 and in North America by 38,000. Most of these peole are target customers for business jets (Capgemini, 2007). These individuals need business jets for comfortable transporation, but comfort is not the basic need. Although they use consultants to make the decision on jet choice, the real driving need is key for the decision. Businessmen who travel frequently with limited budget have the profitable operation as a driving need. On the other hand, higher wealthy individuals have the need of prestige as a driving need (Phelps, 2008). With the occurance of Very Light Jet (VLJ), new customers join this segemet; these customers are pilot owners who have small piston or turbo prop aircraft and seek to own a cheap jet (Abykafua, 2005).

Air taxi segment:

Air-taxi is a new on-demand service which focuses outside the hub airports. The flight duration with Air-taxi is faster than commercial airlines and cheaper than regular charter. Air-taxi users lease the whole aircrafts or a seat in the aircraft. Usually , these aircraft are very small and cheap to own and operate. The estimated utilization of an aircraft is between 1000 to 2000 Hours in one year per plane. Currently, there are many start up companies in operation in the US and Europe (Dysib, 2006). However, due to the finiancial crisis some of these companies closed business and the other reduced their current operation. As a result, business jet manufacturers faced cancelation for many aircraft orders. The new concept is adopted by Federal Aviation Adminstration (FAA) and National Aeronautics and Space Administration (NASA) by implementing new Trafic System efficient for Air-taxi operation, door to door concept (more information is included in section 2.2.1). Transporation System Analysis Model (TSAM) developed by Virginia Tech Air Transportation Systems Laboratory expects the demand for air-taxi services would reach 390,635 trips in 2015 (Baik, Hinze, & Ashiabor, 2006).

Air Charters segment:

Air charter is another on-demand service utilizing business jet aircraft. Charters rent the aircraft to customers during the trip. Unlike Airtaxi, charters use different types of aircrafts. It is possible for a charter to lease a commercial aircraft for different usage. Based on the market shipments, air charter holds the highest percentage of orders. Air charters depend on the demand of the market for business jets. The driving need for them is profitable operation. They also try to match their customer preferences when they chose to purchase any type of aircraft

(Bombardier Aerospace , 2008). The future growth in this market would follow the economy trend.

Fractional owners segment:

This segment consists of fractional share companies that purchase business jet aircrafts and operate them to generate revenue by reselling a fraction of an aircrafts to customers who cannot afford to buy whole aircrafts. Some companies find it profitable to purchase a share for their top executives travel (Bombardier Aerospace , 2008). Fractional share business model led the growth of business jet market between 1995 and 2000. That huge growth results in large fractional share companies such as Net Jet. In the recent years, the market for fractional owners grew by 2% due to market saturation. During the current recession, the demand has slowed down (Thurber, 2008).

Corporate segment:

Large companies such as the Fortune 500 companies, have their own business jet to transport their top executives to increase their profitability. Some companies may use business jets to transport sales personals around the country to save their time. For this reason, they use the jets to transport stakeholders such as customer and suppliers. In addition, some sport teams have their own jets to transport the team members during the season. Anderson Corporate suggested in its business aviation analysis guide 34 utilization strategies for business jet, which would add 39 benefits to the company leading revenue growth, profit margin growth, asset efficiency, employee satisfaction, and customer satisfaction (Aderson, 2001). The growth in segment is very slow and depends on the replacement of the current jet in operation.

Governments segment:

Governments around the world utilize business jet transportation to serve their officials on duty. The reason for that is similar to the corporate reason for using business jets, increasing the productivity. This segment is not only slow in growth, but also has very small size. The future growth depends on the replacement of the current jet in operation.

Non-profit organizations segment:

Non-profit organizations segment is very similar to governments segment in terms of the growth and size. This segment consists of organizations like the United Nations, which use business jets to transport their employees locally and overseas. Other types of organizations are institutes such as the University of Kansas, which may use business jets to transport its basketball team.

2.1.4: Product groups:

The classification of business jet groups is based on the weight, range, and the speed of the aircraft. According to Rolls-Royce, Embraer, and Bombardair, the classification of the business jet should be between 8 to 9 groups based on the weight. These companies have different classes with different names (Bombardier Aerospace , 2008) (Rolls-Royce, 2006) (Pellgrini, 2007). To compare between these classes, the study used four groups and subgroups. This method would allow using similar classifications and introducing a new group, which is supersonic business jet. This group contains jets that have different speed characteristics than others. The other groups are light, medium, and large business jet. These groups contain classic classes based on the weight of the aircrafts.

Light business jet group

Light business jet group contains jets that weigh up to 20,000 Ib. There are mainly three classes in this group; very light jets (VLJ), Entry level, and light jets. Light jets have about 13,000 to 20,000 Ib with a range about 2000 miles. These aircrafts are able to carry eight passengers in average. The lower class is the entry-level aircrafts, which have 13,000 to 10,000 Ib. They can take five to six passengers over 1500 miles. Finally, the lightest class is the very light jets, which has aircraft weight less than 10,000 Ib. This group is newest among all aircraft classes with the capability to carry up to seven passengers with 1500 miles maximum.

Medium business jet group

Medium business jets group is divided into two classes; light medium (LM) and medium (M) aircrafts. Light medium jets have weight between 20,000 and 33,000 Ib. These jets can carry 10 passengers for 2500 miles flight range. The upper class, medium class, includes aircrafts with 33,000 to 50,000 Ib maximum weight. The capability of these aircrafts reaches more than 3,000 miles range with about 15 passengers.

Large business jet group

Large business jet group includes the heaviest aircraft in the business jet market. This group is divided into three classes; long range (LR), very long range (VLR), bizliner (Biz). Long-range jets have 50,000 to 80,000 Ib weight and travel up to 7,000 miles with around 20 passengers. Similarly, very long-range jets can take up to 20 passengers, but for more than 7,000 miles range. The largest class is bizliner jets that have a maximum weight of more than 100,000 Ib. These aircrafts are modified commercial airliners. The capabilities of these jets vary

widely, but the common used aircrafts in business jets are able to carry up to 60 passengers with a range of 6,000 miles.

Supersonic business jet group

Supersonic business jets (SSBJ) have been under development for a long time. However, committed startup companies decided to bring the supersonic concept into the market by 2014. These aircrafts can travel nearly twice the speed of sound. They also could carry 12 passengers for more than 4000 miles range.

2.2: Industrial analysis

2.2.1: Macro-economy factors

Demography

The population of America keeps growing around a rate of 1% annually for a long time. The US Census Bureau estimates the national population of about 305 million in 2009. This rate of growth is considered moderate compared to Asia where they have the highest rate in the world and Europe where they have the lowest in the world. Stable growth in the population ensures the future demand for air transportation (US Census Bureau, 2008).

To study the composition of the population, age distribution is examined using the date published by the US Census Bureau (US Census Bureau, 2008). For age distribution, Figure 3 shows the percentage of each group. In 2009, Generation Y (age between 16 and 30) dominates the population with about 80 million followed by baby boomer (age between 48 and 64) with about 73 million. Most of the baby boomer turned 60. This change in population would result to more consumer expenditure, which is the character of Generation Y (The Still, LLC, 2007).

However, the current customers of business aviation fall in the range between the age of 30 and 65 years.

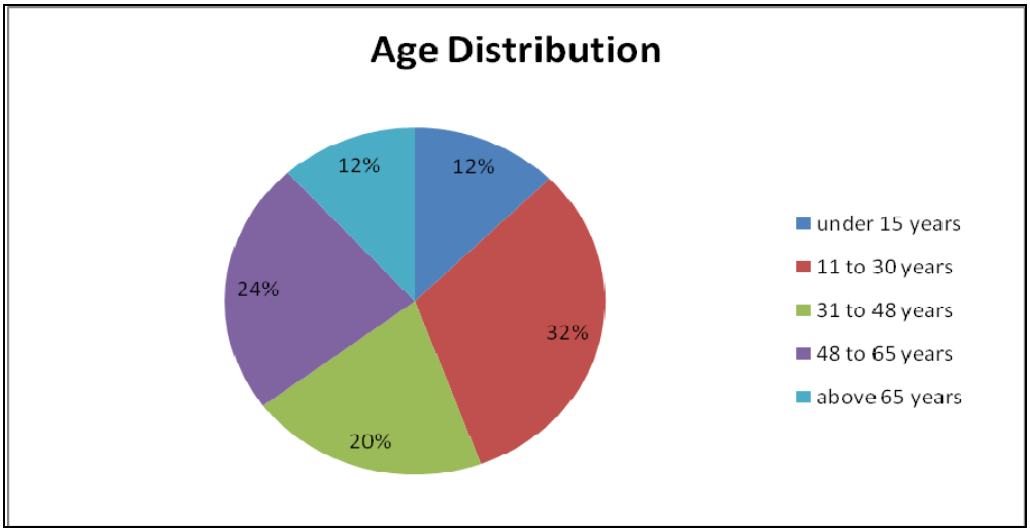

Figure 3: Age Distribution (US Census Bureau, 2008).

Economy

All indications of the world economy show a deep recession in the economy. The U.S. National Bureau of Economic Research announced that the national economy has been in a recession since December of 2007 and is still ongoing. The national GDP fall down by 6.2 % in the fourth quarter of 2008 as an evidence of deep recession (NBER, 2008). The result was worse than what was expected because of the global nature of the crisis. The US Federal Reserve predicts that the recession will continue for 12 to 18 months. The prediction came after approving governmental incentives that would help the economy to reverse its down trend by the end of 2009 and fully recover by 2009 (Hillsenarth & Dvorak, 2009).

The situation of the economy has a great impact on the purchasing power of the consumers, which is escalating the current crises. Because of the recession, the personal

income average decreased by about 0.2% according to the Bureau of Economic Analysis. In addition, the consumer's expenditures power dropped with a higher rate, 1%. This is could be related to employment growth rate to 7.6 % (US Bureau of Labor Statistics, 2008). Therefore, the expected future of the business is not encouraging for the short range.

Many companies are affected by the current situation of the economy. As the sales slow down with a high rate, a growing number of companies in the US are filling for bankruptcy protection. The international trade is also slowing down because of slow demand in America. Today, most companies are not excited to introduce new product even with low development cost. The deficiency in cash and bank loans prevent new businesses to be established across all industries.

Social-culture factors

The current movement in the society is the environmental impact of carbon emission and noise levels. The society's attention has shifted to a higher concern position toward the global temperature increase due to carbon emission. In addition, for communities living near airports, noise level has become a crucial issue. Many people began to prefer environmentally friendly product to traditional product. This change in preference, led by environmental organization, creates tremendous pressure on the governments to set regulations that decease carbon emission and noise level. The need for clean environment phenomena has spread all over the world. Eventually the pressure would transfer to all industries including general aviation industry, which only contributes to less than 0.1 % of total carbon emission (GAMA, 2008).

Another area where culture has changed is the interest in the technical and engineering field. The whole nation has suffered from the decline in the engineering talents during the last years. Most of the current top engineers were inspired by Kennedy challenge to put the first man on the moon. Today, young college students do not have such high inspiration to join the engineering discipline, especially in aerospace engineering. In addition to the reduced pool of engineering talent, the demand for technical labor has increased as demand for aircraft increased and the new technical labor has deceased. This situation puts the whole industry in danger as the time passes. General Aviation Manufacturer Association (GAMA) estimates that the industry needs at least 20,000 workers during the next 10 years. However, as the economy entered a deep recession, many general aviation manufacturers laid off thousands of their workers (GAMA, 2008).

Technological factors:

The general concept of civil aircrafts has not changed since World War II. The conventional concept of the wing-body-tail still is the norm in all new civil aircraft configurations. While military aircraft utilizes new innovative configurations to improve the performance, civil aircraft still uses the traditional configurations because of the high cost of certification. The reason behind that is the tight regulation for safety, which requires additional tests in the certification program for new technology. In addition to test cost, unproven configuration adds more risk to the program to introduce new concepts (GAMA, 2008).

However, new civil aircrafts include new technologies such as structure, propulsion, control, and avionics. In structure, composite material is used to build low cost and low weight

airframes. In addition, new structure configuration is adopted to design efficient airframe. Furthermore, the new jet engine is built with higher and efficient performance by applying new methods in the combustion system (GAMA, 2008). However, the level advancement in the avionics has not matched in all other systems. The new all-glass-cockpit has revolutionized the whole industry. Now, it is possible, for the first time, to have one pilot flying a jet aircraft. The new avionics system simplifies the process and relieves the workload on the pilot during the flight (GAMA, 2008).

New technologies in aircraft traffic system also are emerging to allow aircrafts to take economical trajectory. One system is called special Aircraft and Aircrew Authorization Request (SAAAR Approaches). This system uses satellite based control infrastructure to guide the traffic instead of the old radar based control. The advantage of the new system is its ability to cover any kind of airport without any extra equipment in the ground. For the future, NASA and FAA are working together to develop a new traffic system called Small Aircraft Transportation System (SATS). This system is proposed for introduction in 2025 to increase the capacity of the airspace. SATS promotes for a door-to-door transportation on-demand system (Holmes, Durham, & Tarry, 2004).

Political Factors

As mentioned before, the local and the global pressure would lead the US government to approve new regulations to persuade aviation industry as well as others industries to produce more environmentally friendly products. The US Environmental Protection Agency has already proposed new tight regulation for aircraft engine emission (EPA , 2003). With the rise of the Democratic Party in the White House, the possibility to approve these regulations is higher

since the party supports environmental issues. As a result, the aviation industry needs to prepare to face these challenges.

The industry has succeeded after a number of years, in its effort to push the bill for FAA funding. The fund would help to improve the current traffic system and develop the next generation of air transportation system. The new system is a great opportunity for the whole aviation industry to improve the operation efficiency. However, the coming challenge for the general aviation is the FAA proposal to include fees for utilizing the new system. The new fee would hurt general aviation market and increase airlines domination in the aviation system. Therefore, General aviation manufacturers continue to refuse any attempt to introduce fees to the new system (GAMA, 2008).

2.2.2: Market factors

Market size and growth

The business aviation market has gone though different periods of time when it grew and shrank sharply. Before 1995, the market size had not exceeded three billion dollars; however, the number of the delivered units has been fluctuating. For example, the number of delivered business jets in 1980 is approximately equal to what was delivered in 1998, but the bills of these years were vastly different as shown in figure 4 and 5 (GAMA,2008). The price of the new jet has been increasing sharply after 1994. After 1994, there were two peaks in the market in 2001 and then in 2008.

In 2001, the market size grew to reach $11,240 million with about 600 delivered units. The growth rate in this period is considered the highest in the history of the business jet market. It grew by about 350% from $ 2.1 billion to $ 7.4 billion. The growth was powered by

the growth of the dot-com bubble in the late 90s. The fractional ownership companies exploited the growth in the business to offer their services, which attracted many new customers to the business aviation market (Industry insights, Richard).

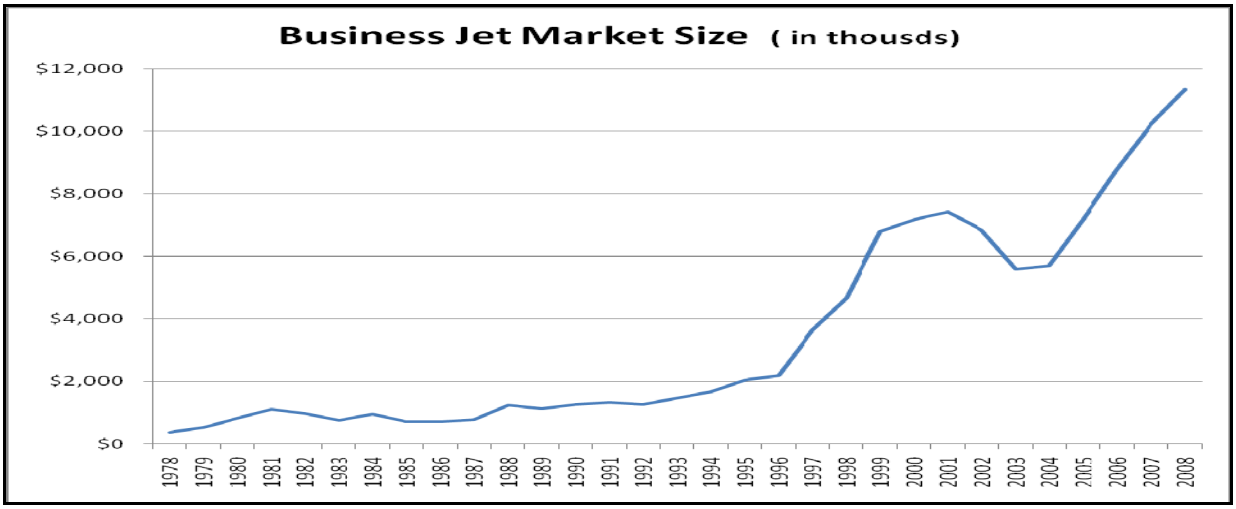

Figure 4 : Business Jet Market Size (GAMA, 2008)

After the high growth in the late 90s, 2001 was the peak, which is followed by a downtrend when the whole economy entered a recession period, but this period did not continue for a long time. The trend reversed its direction to another period of growth in the business jet market in 2004. The market climbed from 8.7 billion in 2004 to reach the peak in 2008 at the level of 11.4 billion with about 955 delivered units (GAMA, 2008).

Of course, the growth in the economy fueled the market growth. However, in 2004 the US government approved tax reduction incentive that would benefit all business jet owners. The new regulation contributed highly in the growth. Price deterioration in 2004 and relatively easy ability to obtain loans also contribute as strong reasons explaining the increase in demand during this period. The possibility to get a new jet became so attractive to many individuals and

firms because the cost to own a business jet became so affordable and profitable (industry insights, Richard).

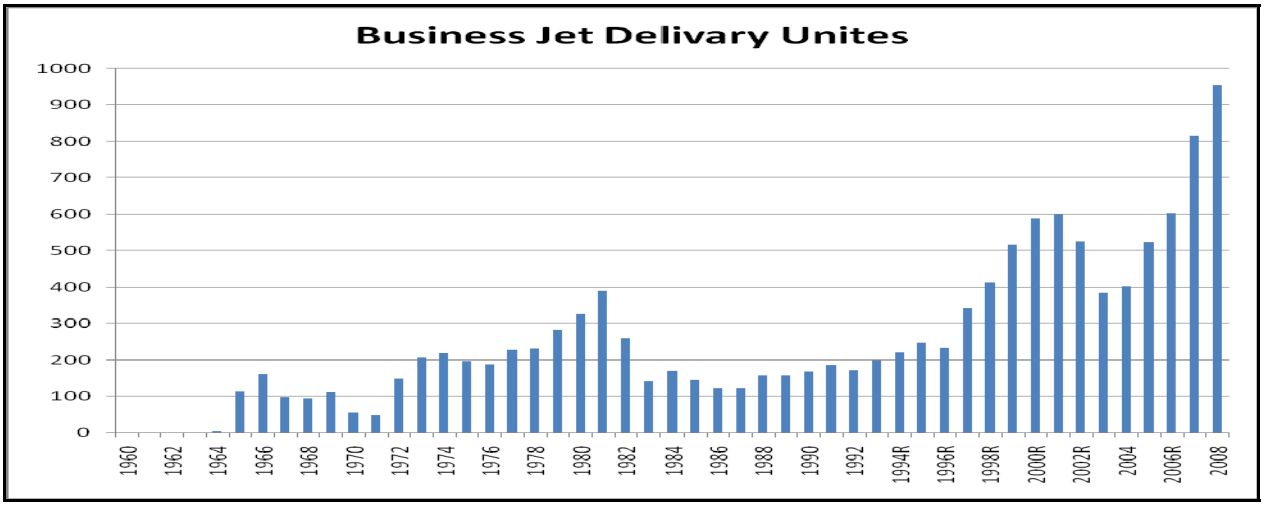

Figure 5 : Business Jet Delivery Unites (GAMA, 2008)

Sensitivity of the economy and seasonal trends

The recent recession hit the business jet market very hard. As the market had just recovered from the last recession, the new recession took away all previous growth engines. Most of the previous recessions recovered using financial institutes' aid. Today, the crisis comes from the financial industry. As a result, the recovery from the current down side depends on the recovery of the financial sector and market demands. The dependency of the business jet market on the health of the whole market makes it correlated to the GDP tends (Industry Inside, Richard). Therefore, as the economy recovers in 2011, the business jet market is expected to start picking up.

The effect of seasonal trends on the business jet market is almost negligible because the sales of new jets are counted after delivering them to customers. The period between sales initiation and delivery date depends on the production schedule. This period usually is a very

long period where the effect of seasonal demand disappears. This is clear from the quarterly deliveries data, which shows no relation between quarters and the amount of the deliveries (GAMA, 2008).

2.2.3: Industry structure factors

Profit margin:

Business jet profit margin varies from one company to another and from one product to another. For most transportation manufacturers, the profit margin is less than 30% in general (Ulrich & Eppinger, 2004). Obtaining real profit margin of products in the market is a hard task since it is confidential information for all companies. To estimate the profitability, this study measures the gross profit margin based on published financial statements. The following table is contains the gross profit margin of a number of aircraft manufacturers. The collected data shows that the profit margin is about 20%.

Table 1: Gross Profit Margins (Hoover's, 2009)

	2008	2007	2006
Boeing	17.30%	20.00%	18.00%
Embraer	-	22.00%	25.30%
General Dynamics	18.30%	17.50%	17.10%
Textron	24.50%	26.50%	25.80%
Average	**20.03%**	**21.50%**	**21.55%**

The profit margin of a business jet varies for several reasons. First, cost of development has a great effect on the total cost of the aircraft. The development cost includes every activity until the aircraft is certified. The cost of development is counted by hundreds of millions if it is not over a billion dollars. In addition, the efficiency of the production plays a major role on the cost of the final product. Another reason is the market demands; higher demands increase the

profit margin. Finally, the power of the customer decreases the profit margin even if the demand is high.

Negotiation power of customers

As the demand for business jets increased in 2008, the power of manufacturing suppliers increased in general. They gained great power over their customers because of the limited number of the big players in the market, as it shown in section 2.3. In addition, the differentiation of jets was so low because of the high efficiency of the product and lake of new products. Another reason was the nature of small-scale individual customers who ordered a limited number of aircrafts. Therefore, manufacturers had large profit margin compared with other industry.

While the global economy is declining, business jet manufacturers lose their power with the falling demands. The profit margin of all aircrafts will go down following the change in the economy. In addition, the appearance of large users of business jets such as large air charters or fractional companies would increase the power of the customers over the suppliers. Furthermore, many companies plan to introduce new jets in the next 5 years. All these factors would lead to a dramatic change in power toward customers (Industry Inside, Richard).

Threat of new entrants

The threat of new entrants comes mainly from the low-end of industry, the light business jet market, because of the high barriers in the other market compared to the benefits. For example, medium and large business jet markets have very high developing costs and have

also mature products that satisfy customers needs. The big players in the market concentrate on the high-end market as it is shown in the competitor analysis section. Therefore, the risk level in these markets is very high because of high level of competition.

On the other hands, there are some areas where the barriers are very low. The Business jet market has no economy of scale production because of the limited number of sales units per year. In addition, manufacturers concentrate on direct marketing more than any other type of promotion methods because of the small number of customers. In addition, products in the same group have little differentiation between each other.

Threat of substitute products

There is no imminent threat for business jet to be substituted with other products. However, there is serious competition in the transportation industry between products that have comparable service range. For short distance, less than 500 miles, helicopters, automobiles, and piston engine aircrafts have good advantage in terms of flexibility and low operation cost, but they are much slower than business jets. In medium distance, 500 to 3,000 miles, high-speed trains have serious competitive advantages such cost, speed, and reliability, but they have not reached the flexibility that business jet offers.

2.3: Competitor analysis

This section reviews all the companies in business jet market. Table 2 shows all the competitors in the business jet market and their products models based on the product groups' classification, which is mentioned in section 2.1.4. For each company, the table indicates the number of models in production or development.

Table 2: Number of business jet aircraft in service and under development per company (this table is constucted based on data collected from companies in the following sections)

	Product groups									
	Light			Medium		Large			SSBJ	
Company	VLJ	Entry	Light	LM	M	LR	VLR	Biz		**Total**
Airbus								3		**3**
Adam	2									**2**
Aerion									1	**1**
Avcen	1									**1**
Boeing								2		**2**
Bombardier			1	2	2	3	1			**9**
Cessna	1	2	3	2	1	1				**10**
Cirrus Design	1									**1**
Dassault					3	2	1			**6**
Diamond	1									**1**
Eclipse	2									**2**
Embraer	1	1		1	2			1	1	**7**
Gulfstream				1	3	2	2		1	**9**
Hawker Beechcraft		1	1	2	1					**5**
Honda Aircraft	1									**1**
SIA									1	**1**
Spectrum	1		1							**2**
Piper Aircraft	1									**1**
Total	**12**	**4**	**6**	**8**	**12**	**8**	**4**	**6**	**4**	**66**

The annual shipment bills report, which is published by GAMA, helps to identify the market share for the major players in the market. The data is shown in figure 6 (GAMA, 2008).

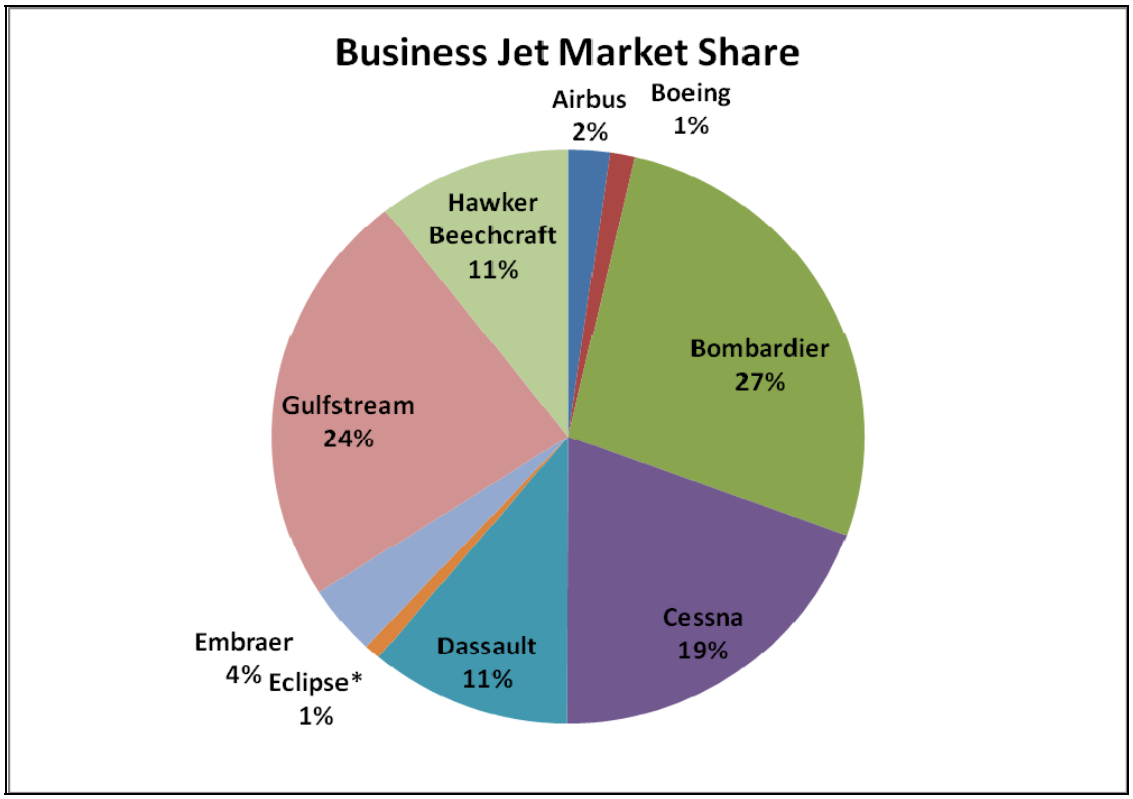

Figure 6: Business Jet Market Share in 2008

Identify competitor

The method used to acquire most of the following information is reviewing the official web site of each company. The main advantage of using companies' website is obtaining the most recent information and the accurate history of these companies. However, for startup companies, the information is obtained through other sources if it is not available in an official web site.

Airbus:

Airbus is a well-known company in the commercial aircraft industry. It is a European company owned by EADS. Airbus customers are all over the world stratified with high quality products. Its brand equity is one of the highest among aircraft manufacturers. The strength of

Airbus is it utilization of the highest and most current technology in its aircrafts, as well as its strong financial health. The company's long experience in manufacturing allows it to introduce new aircrafts in efficient ways. However, Airbus does not focus on business jet market as a primary market. It offers its single aisle (A318 – A319 – A320) as large size aircrafts, specifically Bizliner, in the business jet market (Airbus, 2009).This type of aircraft is the most expensive in the market today. It is expected that Airbus will continue to produce commercial aircrafts and then sell them as large business jets.

Adam Aircraft:

The company is startup seeking to enter the VLJ market with two models. However, Adam Aircraft went through financial troubles. Adam aircraft is still in an unstable situation after it was filed under chapter 7 and sold to AAI Acquisition Inc. It has announced in February 2009 that the company is looking for a new partner to particpate in its effort to stablize the financial situation. With current financial crises and unproven VLJ market, the company is unlikely to find a new partner. Unless the new management secure their financial stability, the company may not survive the recession. The main advantage of the company is their efficient design concept but still the company needs to certify the new aircaft before it is introduced to the market. (AAI Acquisition, Inc, 2009).

Aerion:

Aerion is another startup company which is supported by many industrial companies to develop the first supersonic business jet. The new concept is scheduled to enter the service after 2012 with the price of 80 million dollars. The company has a strong team which has members with long experince in aerospace industry. It is clear that the level of innovation is

very high, since the supersonic concept is new to business jet aircraft. For this reason, the company includes the best minds in the field to make sure they achive their goal to introduce the aircraft on time. However, this project is very risky because the new aircraft is a new concept to a new market. On top of that, they are not the only player in new supersonic market; there are two serious competitors and other companies which is planning to start program to devlop SSJ (Aerion, 2007)

Avcen:

In 2005, Gizmag magazine published that a new mover to VLJ is proposed to be developed for Air-taxi services. The proposed concept is very promising and it offers efficient performance for short distance trips carrying eight passengers. The new aircraft is intended to cost less than one million dollars when it is introduced to the market. There is so little published about Avcen even in their official website. As a result, it seems the business model for this company is not ready now and it would not be a serious player in the market in the near future (Giznag magaine , 2009).

Boeing:

Boeing is a leader in aerospace industry and the number one player in the market. However, they are not concentrating on the business jet market. The business jet market contributes less than 1% to Boeing annual revenue. They offer modified 737 commercial aircrafts as business jets and they call them BBJ1 and BBJ2. These aircrafts are considered as large size bizliner. Boeing also is willing to modify all commerical aircrafts to sell them as VIP aircraft once the are ordered (Boeing, 2009).

Bombardair:

Bombardair is a major player in the business jet market located in Canada with 27 % market share as shown in figure 6 and with about 9 models in service or development mainly concentrated in the mid size jet market. Bombardair strongly focuses on the mid size business jet market with the majority of its models. The company had strategy of growth through acquisitions starting with Canadair and then later de Havilland Canada and Learjet. Today, the company grows by developing larger aircrafts. The company is growing to reach position to compete in the commercial aircraft market. In the business jet market, Bombardair has three categories of its aircrafts. Learjet group is a group of light to mid size aircrafts, Challenger is a group of mid to large size aircrafts, and Global is a group of long-range large size aircrafts. The company's model spread all over the spectrum of business jets but its presence in light jet market is small with only one model compare to other categories. Bombardair is concentrating all its resources for future competition in commercial aircrafts, which is much more profitable than business jet aircrafts (Bombardair, 2009).

Cessna:

Cessna is one of the oldest players in the general aviation market and the business jet market. Today, Texan owns Cessna, which holds about 19% of the business jet market. Based on figure 6, Cessna is ranked third in term of market share in 2008. The portfolio includes the highest number of business jet models. Their strategy is covering the whole market with at least one product in each product class. The only weak part in their coverage is the large size group. As a result, Cessna is developing a new large business jet called Columbus to be introduced in 2014. The company position itself is the best performance to value. It has the fastest civil

aircrafts in operation. Customer loyalty to Cessna is unique in business jet market which gives it big advantage over their competitors. To consolidate its advantage, Cessna keep strong relation with its customers though 10 customer service centers in US and overseas (Cessna, 2008).

Cirrus Design:

Cirrus design is a small aircraft manufacturer in general aviation with successful models that use single piston engines. In 2008, the company obtained $287 million from the sales of its piston engine aircrafts (GAMA, 2008). Cirrus announced its movement to the business jet market to exploit the emerging opportunity for VLJ. It positions itself as the safest aircraft on the market because it uses safety parachute systems in all of its aircrafts. The new aircraft is on flight test phase and scheduled to enter service by 2010 with orders for more than 500 units. Recently, Cirrus declared significant reduction in operation due to the economic recession (cirrusdesign, 2009).

Dassault:

Dassault is one of the big five in the business jet market with about 11 % of market share. Dassault, the French manufacturer, is owned by EADS which is also owns Airbus, the giant firm in the commercial aircraft marketing. The company produces Falcon family in mid to large size business jets with high quality production. Dassault claims that they produce the most efficient aircrafts in the market by utilizing the state of the art technology in aerospace industry. For example, it is the first company to use fly by wire concept in business jets. As major player in the market, Dassault takes good care of its customer with maintenance centers and training programs (Dassault, 2006).

Diamond Aircraft:

Diamond aircraft is another general aviation manufacturer which moves to the business jet market to take advantage of VLJ opportunity. Diamond is an Australian based company with annual sales of $109 million in 2008. The company decided to grow by developing VLJ because the piston market was falling. The new jet is in flight test stage and proposed to be fully certified in 2009. Diamond is trying to position itself as a manufacturer of sporty style aircrafts (Diamond Aircraft).

Eclipse Aviation:

Eclipse is a startup leader in the production of VLJ with orders of more than 1000 units. The company faced cash problems in 2008 due to its inability to obtain new funding. The problem started when its biggest customer canceled its order of 1400 units. After that, Eclipse filed for bankruptcy and sold to Eclipse international (Eclipse Aviation, 2009). However, the new owner failed to secure the money. As a result, the company is pushed to liquidation, which means the end of ambitious new models of VLJ. Eclipse's main failure was underestimation in the jets price by assuming mass production of the aircrafts. This plan was described by Teal group, aerospace market analysts, as an unrealistic plan (Aboulafia, 2008).

Embraer:

Embraer is a Brazilian aircraft manufacturer that holds 4% of the business aviation market. Embraer used to be a governmental organization, but it is a private company right now. The company manufactures all kinds of aircrafts, commercial, military, and business jets. Business jet sector generates 14% only of the annual revenue of the company. Embraer produce five models of business jets, phantom 100, phantom 300, Legacy 500, Legacy 600, and

Embraer 175. The company presents its brand as luxuries with excellent quality products. Embraer aims to consolidate its brand by increasing its market share in business jets. The company hopes by building a strong name to be more effective in its competition with Boeing and Airbus in the commercial aircraft market (Eclipse Aviation, 2009).

Gulfstream:

Gulfstream is ranked second in the business jet market with 24% share. The company is owned by General Dynamics, one of the giant aerospace manufacturer firms. General Dynamics gives Gulfstream financial stability during economic tough times. Gulfstream has long experience in the market, which allows it to position its brand as a reliable business jets maker. It has eight models of business jets in production today, which cover light medium to very long-range business jet market. The company plans to introduce another new very long-range business jet by 2012 (Gulfstream, 2009).

Hawker Beechcraft:

Hawker Beechcraft is one of the big five players in the business jet market with about $ 2.5 billion revenue in 2008 which is about 11% of market share. The company is owned by Raytheon, which is a major aerospace corporation. Hawker Beechcraft has a long history in aerospace industry producing civil and military aircrafts. All of its business jet models are certified under the name Hawker. The latest model is Hawker 900XP, certified in August 2009. This model is considered in the light business jet group. Generally, Hawker Beechcraft concentrates its effort in light and medium the business jet market (Hawker Beechcraft, 2009).

Honda Aircraft:

Honda Aircraft is part of Honda Motor Company, the giant Japanese automotive maker. Honda started a new ambitious program with General Electric Aviation to produce efficient jet engine. To test the new engine, Honda decided to build a very light business jet prototype. The next step from Honda was the decision to enter the VLJ market with its new aircraft. The jet now is in the certification process and expected to enter service in 2010 (Honda, 2009).

Supersonic Aerospace International:

Supersonic Aerospace International is a new start up subsidized by Lockheed Martin, one of the biggest names in the aerospace industry. The company plans to produce one of the first supersonic business jets. With the help of Lockheed Martin's engineering experience, the new concept is in advance progress to enter the market by 2014 (Supersonic Aerospace International).

Spectrum Aeronautical:

Spectrum Aeronautical is a new startup company which utilizes new technology in composite material to produce full composite aircrafts. The new technology reduces the weight of the aircraft, which allows the aircraft to perform much better than a metal aircraft. The company plans to enter market with two models in the light business jet market in late 2009. The new aircraft would suffer low demand due to the economic slowdown, which may put the whole company in danger (Spectrum , 2009).

Piper Aircraft:

Piper Aircraft is a manufacturer of piston aircrafts which tries to escape the fall of the piston market by expanding toward business jet market. Pipers plans to produce a very light jet by 2010. The company has the reputation of producing high performance-single piston aircrafts. As far as its size, it is negligible compared to other big players. The company may suffer severely from the economic crisis (Piper Aircraft,2009).

2.4: Opportunities and threats

After customer analysis, industry analysis, and competitors' analysis ,a number of promising opportunities and risky threats are identified.

Promising opportunities

- Increase the demand for the business jet market as substitute to first class airlines.
- Shifting interest from piston aircraft to small business jet.
- Increase the demand for fractional-owned jets.
- Emerging market for Air-taxi services.
- Emerging new technologies in structure, aerodynamics, and control.
- New ATC systems could increase the capacity of airspace traffics.
- Acquire bankrupt companies.
- Increase the demand for green products.

Threats

- Economy slow-down.
- Weakness in financing resources.
- Tight federal regulations.
- Shift in demand for business jets after the current recession.

3: Project Methodology

3.1 Market Evaluation

In this section, different factors of the market are evaluated based on quantitative comparison between different sub markets of business jets. Note that submarket is presented in the following section as a market of a business jet group such as market for light jet market or medium jets market.

Market size:

The size of each market is determined by the Rolls-Royce demand forecast until year 2025 (Rolls-Royce, 2006). Each market is given a score based on the market size relative to other market.

Table 3: Market size evaluation

	VLJ	Entry	Light	LM	M	LR	VLR	Biz	SSBJ
Market size (billion)	20	10	20	57	61	80	83	10	10
Score	3	1	3	4	4	5	5	1	1

Market growth:

The growth is measured based on the demand in the market. The demand of each market is determined by the Rolls-Royce demand forecast until year 2025 (Rolls-Royce, 2006). Each market is given a score based on the market demand relative to other markets.

Table 4: market growth evaluation

	VLJ	Entry	Light	LM	M	LR	VLR	Biz	SSBJ
Market growth (thousand)	7.5	1.8	3	4	3	2	1.8	0.3	0.3
Score	5	1	3	3	3	1	2	1	1

Market life cycle:

Market life cycle is evaluated based on the cycle level of the market. The level of each market is estimated based on the previous market analysis.

Life cycle	Score
Introduction	5
Development	4
Growth	3
Maturity	2

Table 5: Market life cycle evaluation

	VLJ	Entry	Light	LM	M	LR	VLR	Biz	SSBJ
Market life cycle	Introduction	growth	growth	growth	growth	growth	Maturity	maturity	development
Score	5	3	3	3	3	3	2	2	4

Sensitivity to business cycle:

Sensitivity of business cycle is estimated based on the industry analysis section. High sensitivity has a low score and vice versa.

Table 6: sensitivity to business cycle

	VLJ	Entry	Light	LM	M	LR	VLR	Biz	SSBJ
Sensitivity	high	high	High	medium	medium	low	low	low	low
Score	2	2	2	3	3	4	4	4	4

Entry barriers:

Entry barriers measure the potential for penetration to the market. The estimation of entry barriers in each market is based on the industry analysis. A Market with low entry barriers has a high score.

Table 7: Entry barriers

	VLJ	Entry	Light	LM	M	LR	VLR	Biz	SSBJ
Entry barriers	Very low	Low	medium	high	high	high	high	high	high
Score	5	4	3	1	1	1	1	1	1

Risk-to-benefit of introducing new technology:

The estimation of risk-to-benefit of introducing new technology is based on the assumption that small size aircrafts have low risk to introduce new technology when compared to the benefit.

Table 8: Risk-to-benefit of introducing new technology

	VLJ	Entry	Light	LM	M	LR	VLR	Biz	SSBJ
Risk to benefit	Very low	low	low	medium	high	high	High	medium	medium
Score	5	4	4	3	1	1	1	3	3

Competition intensity:

The possible number aircrafts in the market measures the competition intensity. These numbers are based on the competition. Markets with a high potential number of aircrafts have low scores.

Table 9: Competition intensity

	VLJ	Entry	Light	LM	M	LR	VLR	Biz	SSBJ
Number aircraft in the market	13	4	5	8	12	9	4	6	5
Score	1	5	5	4	2	2	5	4	5

3.2: Market selection

Based on the market evaluation, the following matrix is constructed to select a market using the weight average method. Because there is no criterion to evaluate the weight of each market factor, it is assumed that all factors have the same weight. The market with highest total is the most attractive market for a new product.

Table 10: Market selection

Market factor	VLJ	Entry	Light	LM	M	LR	VLR	Biz	SSBJ
Market size	3	1	3	4	4	5	5	1	1
Market growth	5	1	3	3	3	1	2	1	1
Market life cycle	5	3	3	3	3	3	2	2	4
Sensitivity to business cycle	2	2	2	3	3	4	4	4	4
Entry barriers	5	4	3	1	1	1	1	1	1
Risk to benefit of introducing new technology	5	4	4	3	1	1	1	3	3
Competition intensity	1	5	5	4	2	2	5	4	5
Total	26	20	23	21	17	17	20	16	19

The result shows that VLJ market is the most attractive market for a new product. The VLJ market's highest strength points are potential for high growth, being in introduction stage, low entry barriers, and having low risk-to-benefit of introducing new technology. On other hand, VLJ weakness areas are being very sensitive to business cycles and having a high number of potential competitors. To capture the emerging new opportunity, the new jet should target Air-taxi segment as a primer market and individual owners segment as a secondary market. The new jet also should utilize new technology that could improve the performance of the jet.

3.3: Product Positioning

Positioning (product mix design)

To position the proposed new jet, perceptual mapping needs to be constructed first. Perceptual mapping present the how the customer perceives a product based on selected attributes associated with it. Any product is considered as a group of attributes on which customers based their purchase choices. There are many ways to collect information about customer perception through market research. However, in this study, real data is collected from different companies' official sites about their aircraft parameter. Other sources are not reliable since most of the aircrafts are under developments. Aircraft parameters are used as attributes on which customer bases their decision. These attributes are number of seats, speed, range, and price. Perceptual map positions all VLJs in the market in dimensions of the selected attributes. The following figures show perceptual maps (Dolan, 2001).

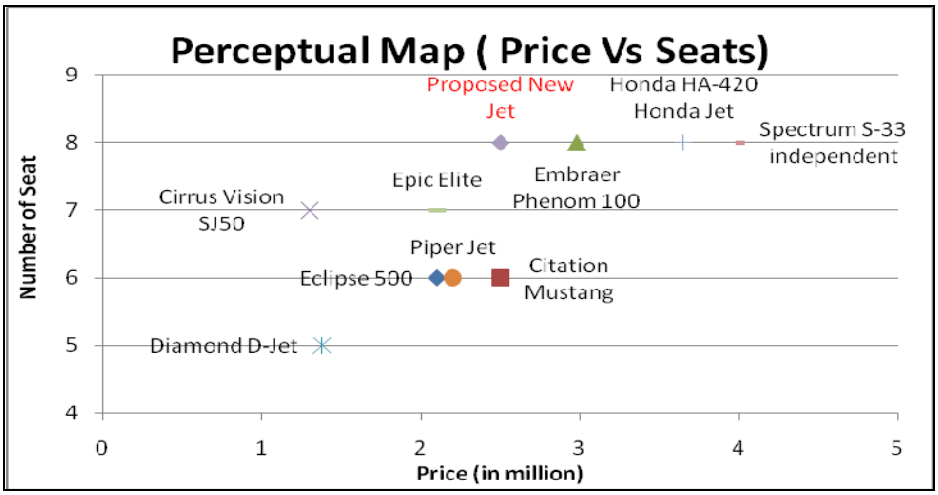

Figure 7: Perceptual Map (Price Vs Seats)

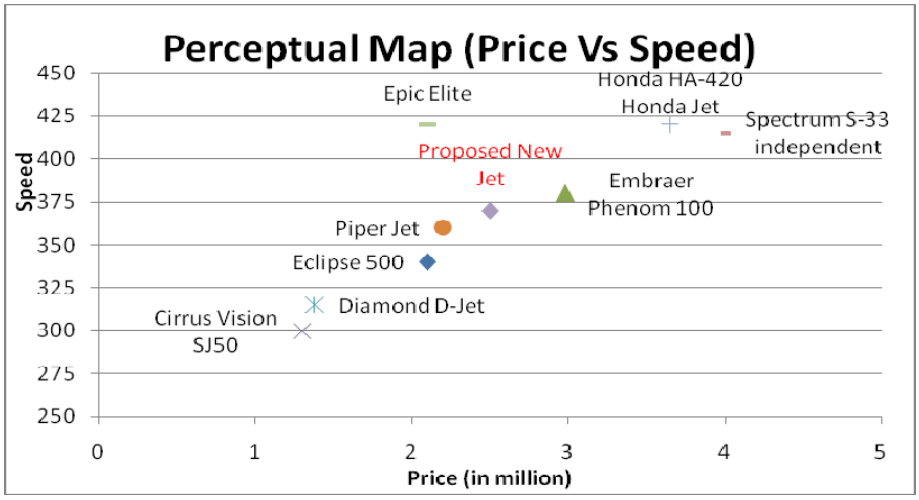

Figure 8: Perceptual Map (Price Vs Speed)

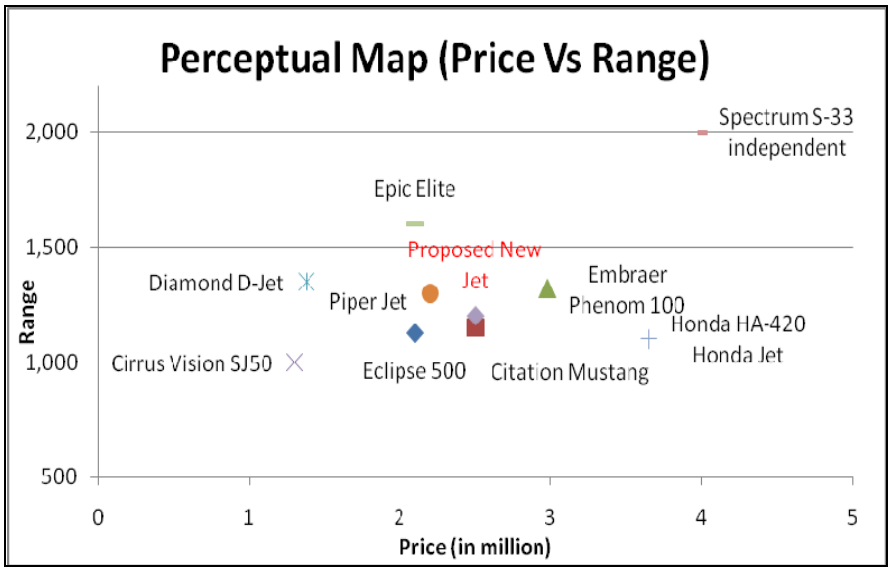

Figure 9: Perceptual Map (Price Vs Range)

The perceptual maps are used to identify the gaps in the market, which represent unsatisfied need in the market. Unsatisfied needs are promising opportunities in the market. A new jet is proposed in a market gap as it is shown in figures 7, 8, and 9. The following table shows the parameters of the proposed new jet compared to other jets, which suppose to enter the market.

Table 11: Business jets' parameters (this table is constructed based on data collected from companies' references, review section

Aircraft	Company	Number of seats		Range	Price
			speed	(Mile)	(million)
Eclipse 500	Eclipse Aviation	6	370	1,125	2.1
Citation Mustang	Cessna	6	340	1,150	2.5
Embraer Phenom 100	Embraer	8	380	1,320	2.98
Cirrus Vision SJ50	Cirrus Design	7	300	1000	1.3
Diamond D-Jet	Diamond Air	5	315	1,350	1.38
Piper Jet	Piper	6	360	1,300	2.2
Honda HA-420 Honda Jet	Honda Aviation	8	420	1,100	3.65
Spectrum S-33 independent	Spectrum	8	415	2000	3.98
Epic Elite	Epic	7	420	1600	2.1
Proposed New Jet	-	8	370	1200	2.5

Market share analysis:

Market share analysis measures how much a new product would perform among the competition. For that reason, conjoint analysis is used to measure the market share of the proposed new jet. Conjoint analysis tests the relativity between the attributes of a product and its preference in the market (Dolan R. , 2001). Usually, the preference is measured through marketing research but the preference is measured through an estimation of market share in this study. The data obtained from the market shows only data for seven aircrafts. Starting from the fact that there are only seven samples as shown in table 12, few attributes are chosen which are number of seats, range, and price.

Table 12: VLJ aircraft preference

Aircraft	Number of seats	Range (Mile)	Price (million)	Preference
Eclipse 500	6	1,125	2.1	1
Citation Mustang	6	1,150	2.5	2
Embraer Phenom 100	8	1,320	2.98	3
Cirrus Vision SJ50	7	1000	1.3	4
Diamond D-Jet	5	1,350	1.38	5
Piper Jet	6	1,300	2.2	6
Honda HA-420 Honda Jet	8	1,100	3.65	7

Next step is the selection of attributes' levels that would contain the whole range of each attribute. The following table shows the levels of each attribute.

Table 13: Attribute level

Attribute	Number of levels	level#1	level#2	level#3
Number of seats	2	5-6	7-8	
Range	3	below 1149	1150 to 1250	Over 1300
Price (in millions)	3	1	2	3

Third step is coding each level which is called dummy coding for independent variables. In this case, the attributes are the independent variables and the pretence is the dependent variable. Number one is used as a dummy variable showing the presence of an attribute and zero shows the absence of the attribute in each card; the card represents the aircraft with the combination of attributes (Orme, 2006). As a result, each attribute would have columns that equal to its number of levels minus one as it is shown in table 14.

Table 14: Dummy coding for independent variable

Preference	6	1050 to 1149	1150 to 1250	1	2
1	1	1	0	0	1
2	1	0	1	0	1
3	0	0	0	0	0
4	0	1	0	1	0
5	1	0	0	1	0
6	1	0	0	0	1
7	0	1	0	0	0

After that, regression analysis is applied to calculate the utilities of each card.

Utility = $b_0 + a_1$ (attribute 1) $+a_2$ (attribute 2) $+a_3$ (attribute 3)

Where, b is the coefficient from regression analysis. The result of the regression is shown in appendix A

The following table shows the calculation of part worth utility.

Table 15: Worth utility calculations

	b	a (formula)	a
Intercept	2.75		
Number of seats			
6	-0.5	a1=b1	-0.5
8	0	a2=b2	0
Range			
1050 to 1149	0.5	a1-a13=b1	1.25
1150 to 1250	1.75	a2-a13=b2	2.5
oever1300	0	a1+a2+a3=0	0.75
Price			
1	0.75	a1-a13=b1	1.67
2	2	a2-a13=b2	2.95
3	0	a1+a2+a3=0	0.92

To calculate the weight of each attribute, the range of each attribute is identified and the weight is calculated based on the following equation (Dolan R. , 2001).

W= attribute range/ total range

Table 16: Attributes weight

Attribute	Range of a	Weight
Number of seats	0.5	12%
Range	1.75	41%
Price	2.03	47%
Total	4.28	100%

Final step is market share calculations. To find the market share of each VLJ in the market, the attribute of each aircraft must be identified. Although there are about 13 concepts that would be introduced to VLJ market, only nine of them have reached to the flight test stage to obtain certification from authority; these aircraft are shown in table 17. Then, the utility of each aircraft is calculated using the previous equation. Finally, the market share of each aircraft is the ratio of the aircraft over the sum of all utilities as shown in Table 17 (Dolan R. , 2001).

Table 17: Market share results

Aircraft	Company	Number of seats	Range (Mile)	Price (million)	Utility	Market share
Eclipse 500	Eclipse Aviation	6	1,125	2.1	7.42	12.53%
Citation Mustang	Cessna	6	1,150	2.5	7.67	12.96%
Embraer Phenom 100	Embraer	8	1,320	2.98	4.42	7.47%
Cirrus Vision SJ50	Cirrus Design	7	1000	1.3	5.67	9.58%
Diamond D-Jet	Diamond Air	5	1,350	1.38	4.67	7.89%
Piper Jet	Piper	6	1,300	2.2	5.92	10.00%
Honda HA-420 Honda Jet	Honda Aviation	8	1,100	3.65	4.42	7.47%
Spectrum S-33 independent	Spectrum	8	2000	3.98	4.42	7.47%
Epic Elite	Epic	7	1600	2.1	6.42	10.84%
Proposed New Jet	-	8	1200	2	8.17	13.80%

The conjoint analysis shows that proposed new jet may take about 13.8 % of the market share. As it is shown in section 3.1, VLJ market demands about 8,000 units in the next 15 years. That means the new jet could capture about 1,108 units in sales. However, the analysis of the conjoint method using available information in the market regarding the preference of the customer is questionable and unreliable to make accurate estimation of the market share. For the purpose of preliminary estimation, this method is a good way to start the estimation for the project. To alleviate inaccuracy, sensitivity analysis is used to obtain study of different possible market share effects. Market share of 13.8 %, 10%, 8% are used to study the effect of different market shares on the profitability.

3.4: Profitability analysis

Sales Estimation

Bass Model is used to estimate sales projection of the proposed new jet. Bass model is a forecasting method which does not require any historical data to estimate the projection. It requires only innovation coefficient (p), imitation coefficient (q), and market size to implement the model. Innovation coefficient measures how quickly early customers would adopt the model when it is introduced to the market. On the other hand, imitation coefficient measures the behavior of the majority of the customers after the experiences of the early customers. In general, Bass model estimates how fast the new product would be adopted in the market.

To implement Bass model, the following equation is used to calculate the number of adaptors (S) during a time period. In this study, the time period is a year.

$$S(t) = [P + ((q/m) N(t-1) [m N(t-1)]$$

Where N= cumulative number of adopter during time t

Innovation coefficient and imitation coefficient usually are obtained from historical introduction experience. In addition, it could be estimated via different levels as sensitivity analysis (Twain, 2007). This study would use the estimation method to generate different projection scenarios. For that purpose, three different scenarios are used to estimate p and q as shown in the following table.

Table 18: Adoption Scenarios

Scenarios	Innovation coefficient (p)	Imitation coefficient (q)	Market size (m)
Early adoption	0.3	0.01	1108
Moderate adoption	0.05	0.5	1108
Late adoption	0.01	0.5	1108

The following Figures show the sales projections in different scenarios. The raw data for these figures are presented in appendix B.

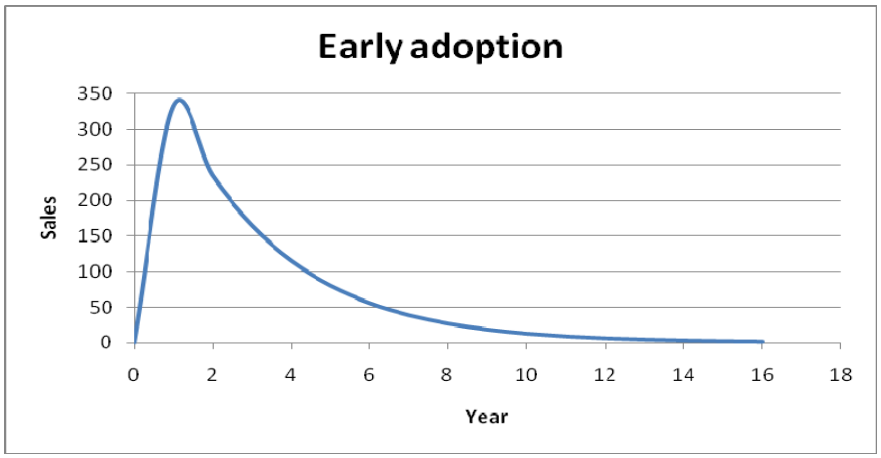

Figure 10: Early adoption sales projection

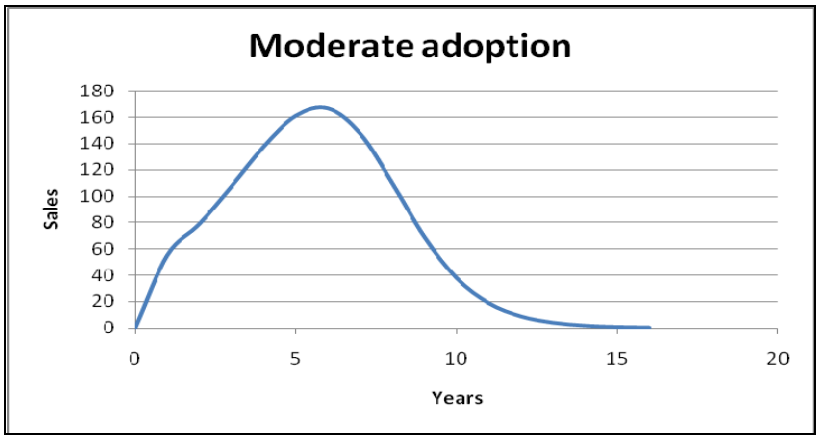

Figure 11: Moderate adoption sales projection

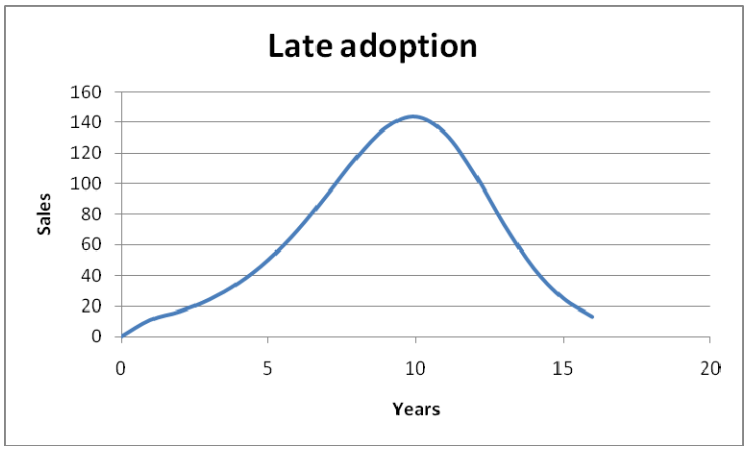

Figure 12: Late adoption sales projection

To evaluate other market shares which are proposed for sensitivity analysis, the moderate adoption scenario is used. The projections are presented in appendix B.

Cost estimation:

The cost of the aircraft is a complex part of the development estimation, especially at early stages before the design process starts. For that reason, the study used the airframe model that helps to estimate the cost of the proposed new jet. The model is developed using cost estimation relations. The cost model provides information about the engineering, manufacturing, and flight test costs. The following equations show the method to estimate different type costs associated with the development of aircrafts (Raymer, 1999).

Required engineering work in hours = $7.07\ W^{0.777}\ V^{0.894}\ Q^{0.163}$

Required tooling work in hours = $8.71\ W^{0.777}\ V^{0.696}\ Q^{0.263}$

Required production work in hours = $8.71\ W^{0.82}\ V^{0.484}\ Q^{0.641}$

Development support cost = $66\ W^{0.63}\ V^{1.3}\ Q^{0.263}$

Flight Test cost = $1807\ W^{0.325}\ V^{0.822}\ FTA^{1.21}$

Manufacturing material cost = $16\ W^{0.921}\ V^{0.621}\ Q^{0.79}$

Quality Assurance = 0.133* manufacturing hours

Where W = empty weight, V = maximum speed, Q = quantity of production years, and

FTA=Flight test aircraft.

NASA software program for cost estimation is used to calculate these data using inputs of W, V, Q, and FTA.

Table 19: Input design parameters

Parameter	Input data
Aircraft Empty Weight (lb.)	6000
Maximum Speed (kn.)	360
Number of flight test aircraft	3
Production Quantity	1000

Table 20: Cost estimation model results

Parameter	Hours (in 1000)	Cost (in million $)
Engineering	2680	334
Tooling	1996	207
Manufacturing	9323	902
Material	-	282
Development Support	-	42
Quality Assurance	3788	364
Flight test	-	18
Total	17786	2131

To apply the obtained information for the cost estimation, the following table is constructed:

Table 21: Aircraft cost estimation

Parameter	Result (in million $)
Aircraft cost	2.131
Development cost	352
Production cost per unit	1.78

Financial Model

In this section, the base-case of the financial model is built as cash flow. The time line for the project is assumed 15 years in sales and 5 years in development. The projection based on Bass model projection provides sales unit every year. For base-case cash flow, the moderate scenario is used with about 20% profit margin. The basic cost of the production is given from cost estimation section. It is also assumed that the marketing and sales budget is 2 % of the annual sales and $10 million for launch expenses. Internal rate of return (IRR) is used to analyze the financial profitability of the project (Ulrich & Eppinger, 2004). The following table shows the base-case of the financial model.

Table 22: Base-case cash flow (note: All numbers are in million dollars except sales units)

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Sales units						55	79	108	138	161	167	148	110	69	38	19	9	4	2	0
Price						2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	
Unit cost						1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	
sales						142	202	275	353	412	426	378	281	177	96.7	48.2	22.8	10.5	4.79	0
Production cost						-99	-141	-192	-245	-287	-297	-263	-196	-123	-67	-34	-16	-7	-3	
Development	-70	-70	-70	-70	-70															
Launch expences					-10															
Marketing						-2.8	-4	-5.5	-7.1	-8.2	-8.5	-7.6	-5.6	-3.5	-1.9	-1	-0.5	-0.2	-0.1	
Cash flow	-70	-70	-70	-70	-80	40.2	57.3	78.2	100	117	121	107	79.9	50.2	27.4	13.7	6.48	2.99	1.36	0
IRR	12%																			

Sensitivity analysis is used to examine the effect of change in adoption scenarios, market share, and profit margin on the profitability of the whole project. Table 23 shows these effects on the profitability based on the IRR values.

Table 23 : The effect of change in market condition in IRR

Change effect	IRR
Early adoption	18 %
Late adoption	7 %
10 % market share	10 %
8 % market share	3 %
30 % profit margin	16 %
10 % profit margin	6 %

4: Findings

Preliminary market assessment:

Currently, the situation in the world economy is affecting the demand for new business jets. As a result, it is not recommended to start the development of a new business jet in the short run, even though the development would take more than the recession period because the playground may change dramatically after the recession. Now, a number of business jet manufacturers are under bankruptcy situations and they may leave the market completely in a year or more. Startup companies are also in a critical situation unless they maintain good cash flow performance, which is unlikely to happen due to the deficiency in commercial loans and the drop in market demands. It may be cheaper to fill the position of the competitors who fail to pass the recession period.

In the long run, the Very Light Jet market is very attractive for introducing a new business jet. A suitable new jet concept could utilize the opportunity in the future demand for air-taxi services. The Very Light Jet market has low barriers for newcomers to introduce new products, which make it less risky to bring new technology to the market. However, low barriers may change the market to a highly competitive one when newcomers enter the market in large numbers. In addition, The Very Light Jet market's sensitivity to business cycles makes it vulnerable to fluctuation in the economy.

Preliminary technical assessment

Adopting new technology in new business jets is more important now than ever, as the competition in the market has become more intense and the regulation for green operation has

become tighter. The effect of technology can have a large effect on the performance of a new jet, which makes it very competitive in the market. However, embracing new technology is not risk free. It involves large risk and large investment in early stages of the project. The risk increases by increasing the size of the aircraft. Therefore, The Very Light Jet market is the best market to introduce new technology for business jets and then apply it for larger-sized jets. The method would decrease the risk to minimum levels.

Preliminary financial assessment

The analysis shows a low market share for the proposed new jet, which leads to low IRR values. It depends on the risk benefit analysis to decide what acceptable IRR is in the business jet market. However, market review shows that business jet manufacturers have about 8% to 25% profit margin. In addition, the sensitivity analysis shows that the maximum IRR is 18%. It would be more than 18% for early adoption with 30% profit margin. Therefore, it is recommended for new business jet to have at least 30% profit margin and more that 15% market share.

5: Conclusion

The study shows that the proposed new business jet is not feasible right now because of the current situation in the market. The current demands for business jets in general are at the lowest level 20 years. The large number of competitors in the market makes it a highly competitive market. As a result, it would be hard to obtain a large market share at this time. With a low market share, the profitability of the new jet is not encouraging for investment.

However, the future demands seem very optimistic for Very Light Jet. At the end of the current recession, the market will see change in positions. Many companies may fail to pass the recession, leaving huge gaps in the market. These gaps would increases the market share for companies that can fill them. As government support increases for a new door-to-door transportation system, the demand for Air-taxi services would increase, leading to high demands for a Very Light Jet. The low cost of Very Light Jets and their ability to operate from very small airports make them attractive for Air-taxi operations.

6: Recommendations for Future Research

To capture any future opportunity, this study needs to be reviewed after the current recession. The revision should include evaluation of the economic situation to study the recession of the financial resources. In addition, the revision requires trends analysis for the business jet market. It also needs to contain reassessment for the market competition to show the possibility to obtain a large market share. For accurate results, any future study should establish market research to involve real customer voices in the study. It would help to measure accurate market share using conjoint analysis.

References

1. AAI Acquisition, Inc. (2009). *About us*. Retrieved March 12, 2009, from http://www.a700jet.com/about-us
2. Aboulafia, R. (2008). *Eclipse Aviation Eclipse Series.* Teal Group Corporation.
3. Aboulafia, R. (2009). *Eclipse Aviation Eclipse Series.*
4. Abykafua, R. (2005, may). Business jet free-fal. *Aerospace America* , p. 18.
5. Aderson. (2001). *Buiness aviation in today's economy.*
6. Aerion. (2007). *About us*. Retrieved March 12, 2009, from Aerion Corp: http://www.aerioncorp.com
7. Aerion. (2007). *About Us*. Retrieved march 11, 2009, from http://www.aerioncorp.com/home
8. Airbus. (2009). *Airbus executive and private aviation*. Retrieved March 2009, from Airbus S.A.S: http://www.airbus.com/en/aircraftfamilies/executive_aviation/
9. Alsem, K. J. (2007). *Straategic Marketing: An applied Perspective.* McGraw-Hill.
10. Baik, T., Hinze, S., & Ashiabor, S. (2006). *Large Trasportation Analysis System Model to County-to-County Demand.* Blacksburg,VA: Virgina Tech.
11. Boeing. (2009). *About us*. Retrieved March 12, 2009, from The boeing company: http://www.boeing.com/commercial/bbj/
12. Bombardair. (2009). *history,about us*. Retrieved March 13, 2009, from Bombardair: http://www.aerospace.bombardier.com/en/corporate/about-us
13. Bombardier Aerospace . (2008). *BUSINESS AIRCRAFT MARKET FORECAST 2008 – 2017.*
14. Capgemini. (2007). *World Wealth Report 2007 .*
15. Cessna. (2008). *About Cessna*. Retrieved March 14, 2009, from Cessna Aircraft Company: http://www.cessna.com/about-cessna.html
16. cirrusdesign. (209). *Cirrus vision SF50*. Retrieved March 2009, from cirrusdesign: http://www.cirrusaircraft.com/vision/specifications.pdf?popup=true
17. Dassault. (2006). *Presentation*. Retrieved March 14, 2009, from Dassualt Aviation: http://www.dassault-aviation.com/en/aviation/group/presentation.html?L=1
18. Diamond Aircraft. (n.d.). *Why diamond*. Retrieved march 15, 2009, from Diamond : http://www.diamondaircraft.com/why/index.php
19. Dolan, R. (2001). *Analyzing Consumer Preferences.* Harvard Business School.

20. Dolan, R. J. (2001). *Analyzing consumer Perceptions.* Harvard Business school.

21. Dysib, E. (2006). *Visible Demand: the new Air-Taxi Market.* Release 1.0.

22. Eclipse Aviation. (2009). *Eclipse Aviation News*. Retrieved March 17, 2009, from Eclipse Aviation: http://www.eclipseaviation.com/company/news/news.php?c=1&id=1405

23. Eclipse Aviation. (2009). *news*. Retrieved March 16, 2009, from Eclipse Aviation Corporation: http://www.eclipseaviation.com/company/news/news.php?c=1&id=1405

24. Embraer. (2008). *Press room*. Retrieved March 17, 2009, from Embraer: http://www.embraer.com/english/content/imprensa/embraer_numeros.asp

25. Embraer. (2008). *Press Room*. Retrieved March 17, 2009, from Emnraer: http://www.embraer.com/english/content/imprensa/embraer_numeros.asp

26. EPA,Environmental Protection Agency. (2003). *Proposed Aircraft Engine Emission Standards.*

27. GAMA. (2008). *General Aviation Airplane Shipment Report.* General Aviation Manufacturers Association.

28. General Aviation Manufacturers Association. (2008). *2008 annual Industry Review and Market Outlook.*

29. Giznag magaine . (2009). *The Jetpod gives vision to the future of flight*. Retrieved March 12, 2009, from http://www.aerioncorp.com/partners

30. Gulfstream. (2009). *History*. Retrieved March 27, 2009, from Gulfstream: http://www.gulfstream.com/news/history/

31. Hawker Beechcraft. (2009). *History*. Retrieved March 27, 2009, from Hawker Beechcraft Corporation: http://www.hawkerbeechcraft.com/about_us/history/

32. Hillsenarth, & Dvorak, P.(February 25, 2009). Twin Crises Feed the spiral. *Wall Street Journal*, 1.

33. Holmes∗, B., Durham, M., & Tarry, S. (2004). *Small Aircraft Transportation System Concept and Technologies.* a.

34. Honda. (2009). *Press Releases*. Retrieved March 27, 2009, from American Honda Motor Co: http://corporate.honda.com/press/article.aspx?id=2006080838554

35. Hoover's. (2009). Companies Income Statement. Retrieved from Hoover's, Inc: http://hoovers.com/boeing/--ID__10221,period__A--/free-co-fin-income.xhtml

36. Kostigen, T. (2006, August 22). What do the very wealthy spend money on? You may not want to know. Retrieved March 19, 2009, from MarketWatch: http://custom.marketwatch.com/custom/iwon-com/news-story.asp?guid=%7bA8DDD7DF-53F9-45FF-AD86-FE711B415FEC%7d

37. NBER,the National Bureau of Economic Research. (2008). *Determination of the December 2007 Peak in Economic Activi.*

38. Orme, B. (2006). *Getting Started with Conjoint Analysis: Strategies for Product.*

39. Pellgrini, M. (2007). *VLJs Panel: what is the European Business Modle.* Embraer.

40. Phelps, M. (2008, July 1). How to buy a jet. *Business JEt Traveler* .

41. Piper Aircraft. (n.d.). Retrieved March 27, 2009, from Piper Aircraft: http://www.newpiper.com/company/heritage.asp

42. Raymer, D. (1999). *Aircraft Design: a coonceptual approach.* AIAA.

43. Rolls-Royce. (2006). *Rolls-Royce business jet overview and long-term Forcast.* Rolls-Royce.

44. Spectrum . (2009). Retrieved March 27, 2009, from Spectrum Aeronautical: http://www.spectrum.aero/spectrum

45. Supersonic Aerospace International:. (n.d.). *about us*. Retrieved March 27, 2009, from Supersonic Aerospace International, LLC (SAI): http://www.saiqsst.com/about.html

46. The Still, LLC. (2007). *When the Boom turns X and Y.*

47. Thurber, M. (2008, February 1). Fractional Ownership: Fractional Market Update. *Business Jet Traveler* .

48. Twain, M. (2007). Forecasting The adoption of a Nwe Proudct. *Harvard business School* .

49. Ulrich, K. T., & Eppinger, S. D. (2004). *Product design and Development.* McGraw Hill.

50. US Bureau of Labor Statistics. (2008). *Statistics tables.*

51. US Census Bureau. (2008). *Curret population report.*

Appendix A

Regression Results SUMMARY OUTPUT						
Regression Statistics						
Multiple R	0.526104281					
R Square	0.276785714					
Adjusted R Square	-3.339285714					
Standard Error	4.5					
Observations	7					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	5	7.75	1.55	0.076543	0.984692008	
Residual	1	20.25	20.25			
Total	6	28				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	5.25	3.897114317	1.347151	0.40652	44.26753238	54.76753238
6	-0.5	7.794228634	-0.06415	0.959217	98.53506477	99.53506477
1050 to 1149	0.5	4.5	0.11111	0.929553	57.6779213	56.6779213
1150 to 1250	1.75	5.95294045	0.29397	0.817979	77.38928013	73.88928013
1	0.75	5.95294045	0.12599	0.920214	76.38928013	74.88928013
2	2	9	0.22222	0.860791	116.3558426	112.3558426

Appendix B

Bass model Result for early adoption:

Year	P	q	m	N	s
0	0	0	0	0	0
1	0.3	0.01	1108	0	332.4
2	0.3	0.01	1108	332.4	235.0068
3	0.3	0.01	1108	567.4068	164.9463
4	0.3	0.01	1108	732.3531	115.177
5	0.3	0.01	1108	847.5301	80.13335
6	0.3	0.01	1108	927.6635	55.61082
7	0.3	0.01	1108	983.2743	38.52457
8	0.3	0.01	1108	1021.799	26.65529
9	0.3	0.01	1108	1048.454	18.42722
10	0.3	0.01	1108	1066.881	12.73152
11	0.3	0.01	1108	1079.613	8.792736
12	0.3	0.01	1108	1088.406	6.070795
13	0.3	0.01	1108	1094.476	4.190663
14	0.3	0.01	1108	1098.667	2.892422
15	0.3	0.01	1108	1101.559	1.996183

Bass model Result for moderate adoption:

Year	P	q	m	N	s
0	0	0	0	0	0
1	0.05	0.5	1108	0	55.4
2	0.05	0.5	1108	55.4	78.945
3	0.05	0.5	1108	134.345	107.7106
4	0.05	0.5	1108	242.0556	137.8851
5	0.05	0.5	1108	379.9407	161.2312
6	0.05	0.5	1108	541.1718	166.7671
7	0.05	0.5	1108	707.939	147.8094
8	0.05	0.5	1108	855.7484	110.0241
9	0.05	0.5	1108	965.7725	69.09668
10	0.05	0.5	1108	1034.869	37.80856
11	0.05	0.5	1108	1072.678	18.86424
12	0.05	0.5	1108	1091.542	8.9297
13	0.05	0.5	1108	1100.472	4.115022
14	0.05	0.5	1108	1104.587	1.872078
15	0.05	0.5	1108	1106.459	0.84662

Bass model Result for late adoption:

year	P	q	m	N	s
0	0	0	0	0	0
1	0.01	0.5	1108	0	11
2	0.01	0.5	1108	11.08	16
3	0.01	0.5	1108	27.5338	24
4	0.01	0.5	1108	51.76325	35
5	0.01	0.5	1108	86.99812	50
6	0.01	0.5	1108	137.2917	70
7	0.01	0.5	1108	207.1388	93
8	0.01	0.5	1108	300.3547	118
9	0.01	0.5	1108	417.8987	137
10	0.01	0.5	1108	554.9407	144
11	0.01	0.5	1108	698.9709	133
12	0.01	0.5	1108	832.0772	106
13	0.01	0.5	1108	938.4416	74
14	0.01	0.5	1108	1011.943	45
15	0.01	0.5	1108	1056.768	25

Appendix C

Cash flow for different cases:

Early adoption																				
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Sales units						332	235	165	115	80	56	39	27	18	13	9	6	4	3	2
Price						2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.6
Unit cost						1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.8
sales						850	601	422	295	205	142	98.5	68.2	47.1	32.6	22.5	15.5	10.7	7.4	5.1
Production cost						-592	-418	-294	-205	-143	-99	-69	-47	-33	-23	-16	-11	-7	-5	-4
Development	-70	-70	-70	-70	-70															
Launch expences					-10															
Marketing						-17	-12	-8.4	-5.9	-4.1	-2.8	-2	-1.4	-0.9	-0.7	-0.4	-0.3	-0.2	-0.1	-0
Cash flow	-70	-70	-70	-70	-80	241	171	120	83.6	58.2	40.4	28	19.3	13.4	9.24	6.38	4.41	3.04	2.1	1.4
IRR	18%																			
Late adoption																				
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Sales units						11	16	24	35	50	70	93	118	137	144	133	106	74	45	25
Price						2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.6
Unit cost						1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.8
sales						28.3	42.1	62	90.1	129	179	238	301	350	368	340	272	188	115	64
Production cost						-20	-29	-43	-63	-90	-124	-166	-209	-244	-256	-237	-189	-131	-80	-44
Development	-70	-70	-70	-70	-70															
Launch expences					-10															
Marketing						-0.6	-0.8	-1.2	-1.8	-2.6	-3.6	-4.8	-6	-7	-7.4	-6.8	-5.4	-3.8	-2.3	-1
Cash flow	-70	-70	-70	-70	-80	8.04	11.9	17.6	25.6	36.5	50.7	67.7	85.3	99.5	105	96.6	77.2	53.4	32.5	18
IRR	7%																			

10 % market share																				
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Sales units						40	57	78	100	116	120	107	79	50	27	14	6	3	1	0
Price						2.77	2.77	2.77	2.77	2.77	2.77	2.77	2.77	2.77	2.77	2.77	2.77	2.77	2.77	
Unit cost						1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	
sales						111	158	215	276	322	334	296	220	138	75.6	37.7	17.9	8.23	3.74	0
Production cost						-71	-101	-138	-177	-207	-214	-190	-141	-89	-49	-24	-11	-5	-2	
Development	-70	-70	-70	-70	-70															
Launch expences					-10															
Marketing						-2.2	-3.2	-4.3	-5.5	-6.4	-6.7	-5.9	-4.4	-2.8	-1.5	-0.8	-0.4	-0.2	-0.1	
Cash flow	-70	-70	-70	-70	-80	37.4	53.3	72.7	93	109	113	99.7	74.2	46.6	25.5	12.7	6.03	2.78	1.26	0
IRR	10%																			
8 % Market share																				
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Sales units						32	46	62	80	93	96	85	64	40	22	11	5	2	1	0
Price						2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	2.56	
Unit cost						1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	
sales						81.8	117	159	204	238	246	218	163	102	55.8	27.9	13.2	6.08	2.76	0
Production cost						-57	-81	-111	-142	-166	-171	-152	-113	-71	-39	-19	-9	-4	-2	
Development	-70	-70	-70	-70	-70															
Launch expences					-10															
Marketing						-1.6	-2.3	-3.2	-4.1	-4.8	-4.9	-4.4	-3.3	-2	-1.1	-0.6	-0.3	-0.1	-0.1	
Cash flow	-70	-70	-70	-70	-80	23.2	33.1	45.2	57.8	67.6	69.9	62	46.1	29	15.9	7.91	3.74	1.73	0.78	0
IRR	3%																			

30 % profit margin																				
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Sales units						55	79	108	138	161	167	148	110	69	38	19	9	4	2	0
Price						2.77	2.77	2.77	2.77	2.77	2.77	2.77	2.77	2.77	2.77	2.77	2.77	2.77	2.77	
Unit cost						1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	
sales						153	219	298	382	447	462	409	305	191	105	52.3	24.7	11.4	5.19	0
Production cost						-99	-141	-192	-245	-287	-297	-263	-196	-123	-67	-34	-16	-7	-3	
Development	-70	-70	-70	-70	-70															
Launch expences					-10															
Marketing						-3.1	-4.4	-6	-7.6	-8.9	-9.2	-8.2	-6.1	-3.8	-2.1	-1	-0.5	-0.2	-0.1	
Cash flow	-70	-70	-70	-70	-80	51.8	73.8	101	129	151	156	138	103	64.6	35.3	17.6	8.35	3.85	1.75	0

IRR	16%

10 % profit margin																				
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Sales units						55	79	108	138	161	167	148	110	69	38	19	9	4	2	0
Price						2.34	2.34	2.34	2.34	2.34	2.34	2.34	2.34	2.34	2.34	2.34	2.34	2.34	2.34	
Unit cost						1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	1.78	
sales						130	185	252	323	377	390	346	257	162	88.5	44.1	20.9	9.63	4.38	0
Production cost						-99	-141	-192	-245	-287	-297	-263	-196	-123	-67	-34	-16	-7	-3	
Development	-70	-70	-70	-70	-70															
Launch expences					-10															
Marketing						-2.6	-3.7	-5	-6.5	-7.5	-7.8	-6.9	-5.1	-3.2	-1.8	-0.9	-0.4	-0.2	-0.1	
Cash flow	-70	-70	-70	-70	-80	28.4	40.5	55.3	70.8	82.7	85.6	75.9	56.5	35.5	19.4	9.68	4.58	2.11	0.96	0

IRR	6%